(12) UK Patent Application (19) GB (11) 2 187 398 (13) A

(43) Application published 9 Sep 1987

(21) Application No 8705541

(22) Date of filing 22 Dec 1983

Date lodged 10 Mar 1987

(60) Derived from Application No 8334241 under Section 15(4) of the Patents Act 1977

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(51) INT CL[4]
F27B 15/09

(52) Domestic classification (Edition I)
B1F 221 412 614 CEK
U1S 1699 B1F

(56) Documents cited
GB A 2082739 GB 1078522
GB 1402174 GB 0960902
GB 1247601 EP A1 0046993

(58) Field of search
B1F
F4B
Selected US specifications from IPC sub-classes F27B B01J

(54) Method and apparatus for heat treatment

(57) Clay articles, particularly clay roofing tiles, are preheated and then fired preferably in a fluidised bed furnace, generally at a 1000 to 1100°C.

Apparatus comprises a preheatment tunnel (4), means for moving the articles to be treated along the preheatment tunnel, means for supplying heated gas along the preheatment tunnel to preheat the articles therein, means positioned at the end of the preheatment tunnel to remove articles from the tunnel and place them in a firing furnace (10), the firing furnace (10), a cooling tunnel (5), means for removing the articles from the firing furnace and introducing them into the cooling tunnel, means for moving the articles along the cooling tunnel, and means for supplying cooling gas along the cooling tunnel to cool the articles therein.

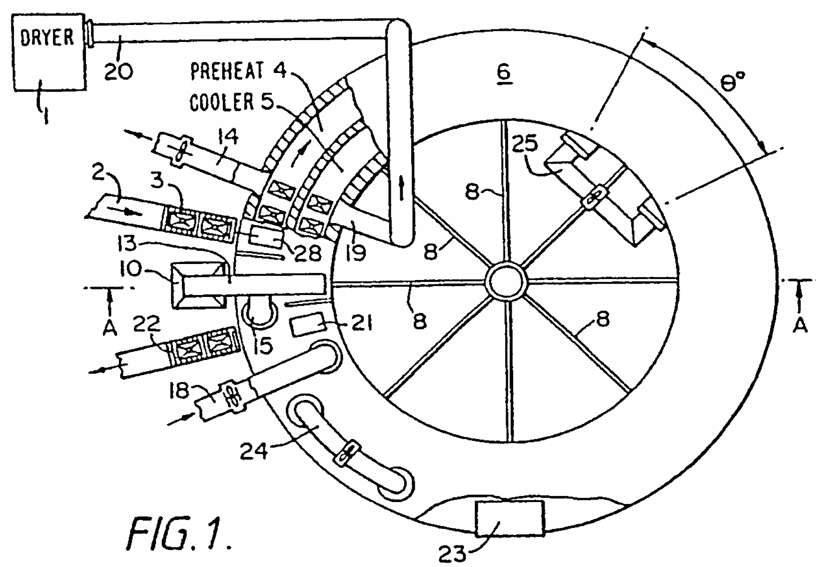

FIG. 1.

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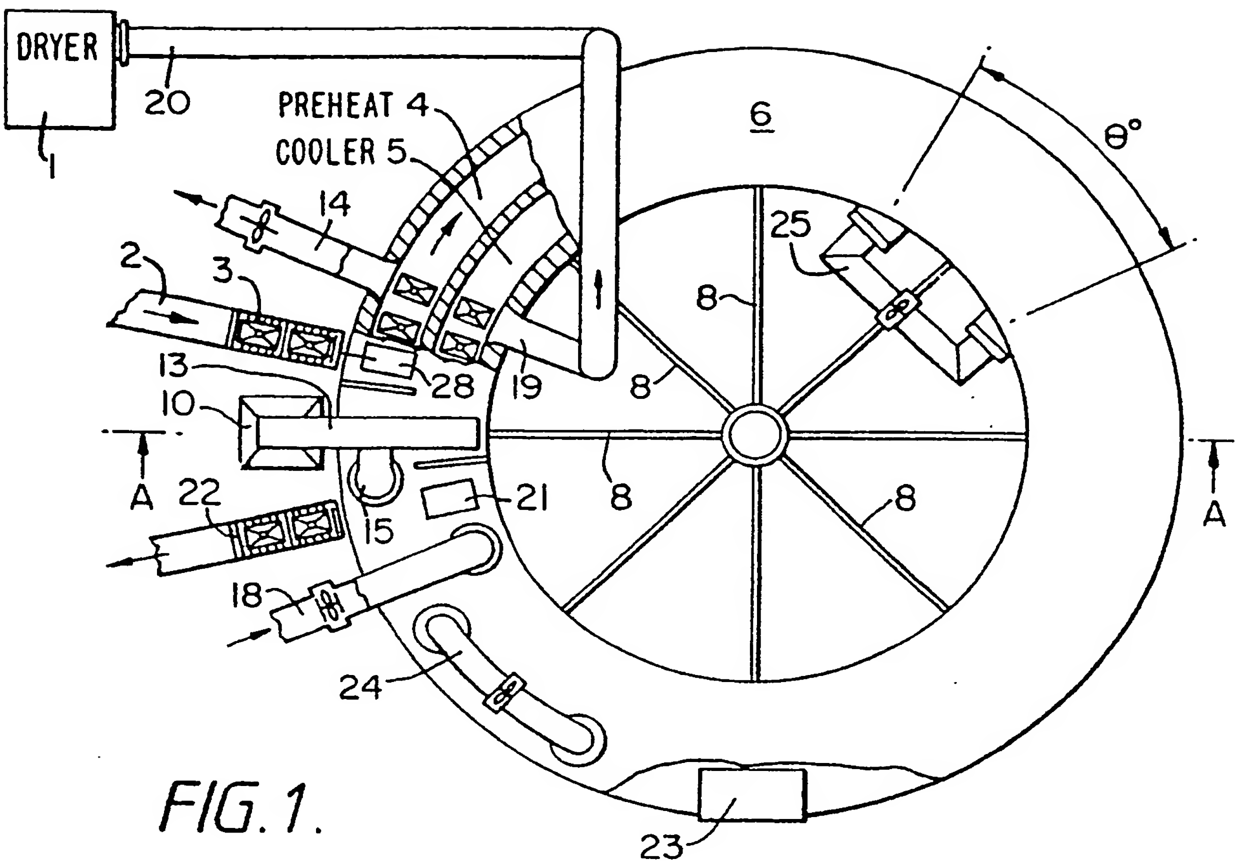
DRYER
1
20
PREHEAT 4
COOLER 5
6
θ°
14
2
3
25
8
13
28
19
10
A
22
15
21
18
24
23
A

FIG. 1.

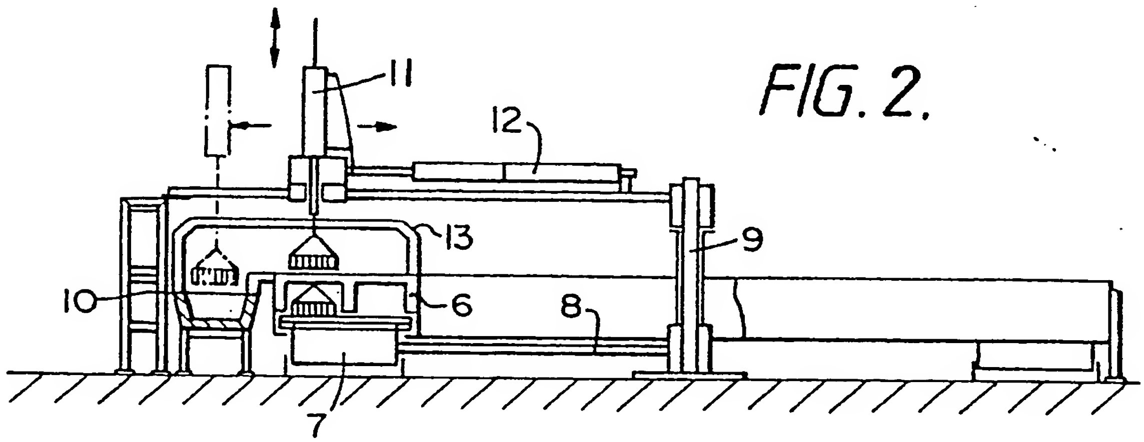
11
12
13
9
10
6
8
7

FIG. 2.

SPECIFICATION

Method and apparatus for heat treatment

This invention relates to a method and apparatus for heat treatment, particularly for the heat treatment of clay articles such as roofing tiles.

In the production particularly of clay roofing tiles, the tiles are dried and subjected to heat treatment under which conditions the tiles develop their strength. The heat treatment comprises a preheating to about 600°C and a firing of the tiles at about 900 - 1150°C followed by cooling.

Traditionally these functions are carried out in a kiln. Thus the kiln is stacked full of dried clay tiles and then sealed, e.g. bricked-up. Then the temperature within the kiln is gradually raised to preheat the tiles and then raised further for the firing treatment. Then the furnace must be left as a whole to cool until it can be broken open and the tiles removed. This process is very inefficient because of the difficulty of controlling temperature within the furnace and particularly because the temperature through the furnace is non-uniform. Thus while some tiles within the furnace may be subjected to optimum firing treatment others are subjected to insufficient firing treatment and others to excess firing treatment. In fact the rejects of tiles from kilns treated in this traditional way are very high. And even those tiles which are accepted may not be of very uniform colour.

Furthermore this traditional process is a batch process taking several days or weeks for the furnace to be stacked up, heated, allowed to cool and then unstacked. Also from a heat efficiency point of view it involves very high heat losses.

In order to overcome some of the disadvantages of the traditional kilns, more recently clay tiles have been heat treated in tunnel furnaces through which the tiles are passed on a continuous basis. This is a considerably more efficient process than the conventional kiln process since generally speaking the treatment times are shorter and the heat of hot exhaust gases can be conserved and used elsewhere, e.g. in the drying of the tiles. However even this process is difficult to control and there are high losses of tiles due to non-uniform treatments and the treatment, though shorter than the treatment in a traditional kiln, still can take several days.

According to the present invention there is provided a process for the treatment of clay articles which process comprises preheating dried clay articles, subjecting them to a firing treatment in a fluidised bed furnace, and then allowing them to cool.

The process according to the present invention may thus be used for the treatment of suitable clay articles but in particular is useful for the treatment of clay roofing tiles.

The preheat temperature for clay tiles at which the tiles are introduced into the fluidised bed furnace is generally at least 600 to 650°C. The fluidised bed furnace can fire the tiles at 900 to 1200°C though generally the firing temperature will be 1000 to 1100°C.

It has been found that using a fluidised bed furnace, the heat transfer within the furnace is very much quicker than in the furnaces previously used.

This means that residence times within the furnace for firing are very much reduced making the method according to the present invention capable of being operated at much shorter time periods than the conventional processes. Indeed the average residence time of a clay tile in the fluidised bed furnace need generally only be six minutes. Furthermore temperature control within the fluidised bed furnace is easy to achieve with uniformity of temperature through the furnace. This means that each tile can be given substantially uniform firing treatment and that the optimum firing conditions are readily obtained so that tiles of uniform colour as required are obtained and also the reject levels of fired tiles are kept to a minimum. This uniformity of treatment is particularly the case when each tile is fired individually; that is during the firing process each tile is held away from the other tiles with an air gap between. This contrasts with conventional firing practice where the tiles are fired in so-called bungs, each bung consisting of a number of tiles pressed together such that there can be no air circulation between tiles. Moreover it has been found that using very short firing treatments as are possible according to the present invention improved tile strengths can be obtained.

The invention also provides apparatus for the heat treatment of articles, particularly for the heat treatment of clay roofing tiles, which apparatus comprises:

a preheatment tunnel,

means for moving the articles to be treated along the preheatment tunnel,

means for supplying heated gas along the preheatment tunnel to preheat the articles therein,

means positioned at the end of the preheatment tunnel to remove articles from the tunnel and place them in a firing furnace,

the firing furnace,

a cooling tunnel,

means for removing the articles from the firing furnace and introducing them into the cooling tunnel,

means for moving the articles along the cooling tunnel, and

means for supplying cooling gas along the cooling tunnel to cool the articles therein.

The firing furnace is preferably a fluidised bed furnace.

The apparatus according to the present invention provides, in a single unit, apparatus in which preheating, firing treatment and cooling can be carried out. Also the apparatus can be readily designed for heat efficiency and for ease of control of the temperature within.

The preheatment and cooling tunnels can have longitudinal paths. However it is preferred that they have circular paths and are arranged to be concentric. The tunnels may have heat insulating roofs to reduce heat loss, the floors of the tunnel being movable relative to the roofs. With the concentric configuration, the floors of the two

tunnels may together be formed by a circular annular table, which is rotated about the centre under the tunnel roofs. Preferably the movement is stepwise, the length of dwell time between each step being readily variable according to the desired lengths of treatment in the tunnel.

Thus with the apparatus according to the present invention those parts of the heat treatment process, i.e. the preheatment and cooling, which require to be carried out under controlled and slow conditions can be according to the present invention and the high temperature firing treatment i.e. the furnace treatment, which can be a quick treatment step, can be carried out outside of the tunnels.

The articles being treated are removed from the preheatment tunnel and inserted into the furnace where they are fired and then, suitably the same, means remove the articles from the furnace and then place them into the cooling tunnel. This can suitably be effected pneumatically.

For the treatment of roofing tiles the furnace is suitably a fluidised bed furnace in which the firing time is required to about six minutes. Thus suitably the stepwise movements of the tiles within the tunnels is also six minutes between each step. In this way the removal of the articles from the tunnel to the furnace and back to the cooling tunnel is readily synchronised with the running of the remainder of the apparatus.

The heating gas for use in the preheatment tunnel is suitably outlet gas from the furnace. This is preferably in contra-flow to the movement of the articles through the preheatment zone. Thus in the preheatment zone the hot gases are hottest at the end of the zone and coolest at the beginning where they may be exhausted to the atmosphere. The cooling as for the cooling tunnel is suitably ambient air introduced into the system. Again the air is preferably in contra-flow to the movement of articles through the cooling tunnel. Thus the air exhausted from the cooling zone is warmed and this warm air may be used in the drying of the tiles if desired.

Temperature control within the tunnels may be important. For example in the cooling of clay roofing tiles, adequate dwell time at 573°C has been found to be important for the strength of the final tiles. When temperature conditions like this are important it is convenient to provide the tunnels with bypass chambers so that, over a particular section of the tunnel, the gas can be recirculated to ensure the correct temperature over that part of the tunnel.

The invention is further illustrated, by way of example, with reference to the accompanying drawings wherein:

Figure 1 shows, partly in section, a plan view of apparatus for use in the heat treatment of clay roofing tiles, and

Figure 2 is a part section along the line A-A of Figure 1.

Referring to the drawings, tiles from a dryer 1 pass along a conveyor 2. Conveniently the tiles are individually held so that air can circulate therebetween in heat resistant steel alloy baskets 3, each basket 3 containing approximately 50 tiles. At the end of conveyor 2, each basket 3 is inserted into a preheatment tunnel 4. Conveniently the baskets are lifted from the end of the conveyor 2 by an operator and inserted through a hole 28 in the roof of the preheatment tunnel 4.

The preheatment tunnel 4 is annular and concentric therewith and adjacent thereto inside preheatment tunnel 4 is a cooling tunnel 5. The tunnels are separated in their roof sections made of formed heat insulating material 6. However their floors are in fact common being comprised of a circular annular table member 7 under both of the roof sections of the heat insulating material 6. Naturally care needs to be taken that heat losses at the tunnel edges are kept to a minimum. The table member 7 is connected via radial arms 8 to a central column 9 about which table member 7 can rotate. A table control index 23 mounted at the outside of table member 7 controls a pneumatic cylinder (not shown) which causes on each forward stroke of cylinder the table member 7 to move one step about the central column 9. Thus the table member 7 constituting the floors of the two tunnels is caused to rotate stepwise. In the embodiment shown, the table member 7 and thus articles in the tunnels 4 and 5 on the table member 7 are rotated clockwise.

To the outside of the annular ring formed by tunnels 4 and 5 there is a fluidised bed furnace 10. Above the tunnels at this point is mounted a hoist 11 capable of lifting and lowering the crates 3. Also there is provided a horizontal pneumatic cylinder 12, the extension of pneumatic cylinder 12 governing whether the hoist 11 is over the preheatment tunnel, over the fluidised bed furnace, or over the cooling tunnel. At this point the crates 3 must of course be capable of being lifted through the roof of the preheatment tunnel 4 and being lowered into the cooling tunnel 5. Thus there will be a hole in the roofs of these tunnels here though an overall roof 13 covering both these tunnels here though an overall roof 13 covering both these tunnels and the fluidised bed surface will keep heat losses to a minimum.

The hot exhaust gases from the fluidised bed furnace 10 are introduced via inlet 15 into the end of preheatment tunnel 4. In preheatment tunnel 4 these exhaust gases flow in an anti-clockwise direction in contra-flow to the articles in the tunnel which are rotated clockwise. The cooled gases after passage through tunnel 4 are exhausted to the atmosphere through outlet 14.

Ambient cooling air is introduced through inlet 18 into the cooling tunnel 5. This ambient cooling air travels through the tunnel in the anti-clockwise direction, i.e. in contra-flow to the movement of articles through the tunnel, and is exhausted from the cooling tunnel at outlet 19 and is recycled via pipe 20 to the dryer 1.

Adjacent the inlet 18 there is a position 21 in the cooling tunnel 5 from which crates 3 of cooled tiles are removed, placed on a conveyor 22 off to despatch.

As mentioned above, for most accurate control of temperature, the tunnels may be provided with bypass chambers so that the heating or cooling gas is recirculated along a short length of the respective tunnel. This will ensure particularly good

temperature control in the tunnel. Thus for example in the cooling of clay tiles, the temperature dwell at 573°C has been found to be important to the final strength of the tiles. For illustration purposes there are shown in Figure 1 bypass chambers 24 and 25 for the preheatment and for the cooling tunnels respectively. The actual positioning of these tunnels will depend upon the desired effects within the tunnels for any particular heat treatment process.

In use of the apparatus according to the present invention the tiles from dryer 1 in crates 3 are moved along conveyor 2 where they are introduced, by means of an operator, into the preheatment tunnel 4. This floor is pneumatically driven to rotate stepwise in a clockwise direction. The length of dwell time between each movement is controlled by the table index control mechanism 23. The crates 3 of tiles move clockwise in contra-flow to heating gas introduced into the preheatment tunnel at inlet 15 from the furnace 10. This gas is exhausted from the preheatment tunnel 4 via outlet 14.

When the crates 3 in the preheatment tunnel 4 reach the position adjacent the fluidised bed furnace 10, the hoist 11 is lowered and engages the crate and lifts it up out of the preheatment tunnel 4. The pneumatic cylinder 12 is extended causing the hoist 11 to be moved leftwards as shown in Figure 2 above the fluidised bed furnace 10 and then the hoist 11 is lowered to lower the crate 3 into the furnace. The crate 3 remains in the fluidised bed furnace 10 for the required amount of time (usually six minutes) and then the hoist 11 raises the crate up out of the furnace, the pneumatic cylinder 12 is returned to move the hoist 11 in a rightwardly direction as seen in Figure 2 over the cooling tunnel 5. The hoist 11 then lowers the crate 3 into the cooling tunnel 5.

In the cooling tunnel 5 the crate is again moved stepwise in a clockwise direction. Thus the crate rests on the part of table member 7 forming the floor of the cooling tunnel. This table member 7 is of course being moved in a clockwise direction. In the cooling tunnel 5 there is a contra-flow of ambient cooling air which is introduced at inlet 18 and exhausted at outlet 19 and recycled to the dryer 1 via pipe 20.

The bypass chambers 24 and 25 can be used to optimise the temperature in the tunnels along lengths of them as desirable according to the treatment process.

As mentioned above, the appropriate treatment time for clay tiles in the fluidised bed furnace is preferably six minutes. Thus in order to synchronise the whole apparatus it is suitably run such that the dwell time between each step of the rotation of the table member 7 providing the floors of the preheatment tunnel and the cooling tunnel is six minutes. In the preheatment tunnel 4 the temperature of the tiles is raised from their temperature on the conveyor 2 which will be suitably ambient or may be a little warmer having regard to the fact that the tiles have come from the dryer up to about 600 to 650°C by the time the tiles have been through one revolution in the circular pathed preheatment tunnel 4, at which time they are in the position adjacent the fluidised bed furnace 10. After the six minute treatment in the fluidised bed furnace 10, the tiles are then inserted into the cooling tunnel 5 and then cooled down to substantially ambient temperature in one revolution in order that they may be removed from the cooling tunnel 5, placed on the conveyor 22 and sent off to despatch.

Thus this apparatus is convenient and economical to run. The tiles obtained with such apparatus are of good uniform quality and the reject rate is accordingly very low. Furthermore tiles can be obtained with the apparatus according to the present invention in less than 12 hours as compared with the several days required previously even when continuous tunnel kilns were used.

CLAIMS

1. Apparatus for the heat treatment of articles, particularly for the heat treatment of clay roofing tiles, which apparatus comprises:
a preheatment tunnel,
means for moving the articles to be treated along the preheatment tunnel,
means for supplying heated gas along the preheatment tunnel to preheat the articles therein,
means positioned at the end of the preheatment tunnel to remove articles from the tunnel and place them in a firing furnace,
the firing furnace,
a cooling tunnel,
means for removing the articles from the firing furnace and introducing them into the cooling tunnel,
means for moving the articles along the cooling tunnel, and
means for supplying cooling gas along the cooling tunnel to cool the articles therein.

2. Apparatus according to claim 1 wherein the firing furnace is a fluidised bed furnace.

3. Apparatus according to claim 1 substantially as described with reference to and as illustrated in the accompanying drawings.

Printed for Her Majesty's Stationery Office by Croydon Printing Company (UK) Ltd, 7/87, D8991685.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.